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ABSTRACT

Recent reports have revealed that inequalities exist between males and females, racial minorities and whites, and rich and poor in accessibility to and use of computers. This study reviews the research in the field of computer-based education to determine the extent of and reasons for these inequities. The annotated research articles are arranged into five sections and within the sections, arranged chronologically. Section One consists of surveys and studies dealing with the availability of computers as related to school characteristics. Section Two focuses on differences in access to and use of computers as related to user characteristics. Section Three focuses on knowledge of computers as related to user characteristics. Section Four consists of surveys of attitudes toward computers as related to user characteristics. Section Five contains studies of computers used as related to teacher characteristics. A discussion and set of conclusions follow. It is recommended that (1) states develop equitable means of distributing educational resources; (2) low-income, minority, and female students be encouraged to use computers for computer science and programming; (3) low-income and minority students' knowledge and attitudes toward computers be researched; (4) subject areas other than mathematics use computers; (5) traditional computer classes be modified and offered as non-mathematics electives; (6) counselors, teachers and parents encourage females to take computer courses; and (7) computer environments emphasize cooperative work at computers for females. (APG)

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INEQUITIES IN COMPUTER EDUCATION

DUE TO GENDER, RACE, AND SOCIOECONOMIC STATUS

BY

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Introduction

Our society, once based upon the production of goods by industry, is changing to one based upon the services produced by information (Hade:1982). The driving force behind this change is the computer. Integrating computers into the school curriculum is essential if public education is "to teach the skills necessary to function productively in society" (Hade:1982). However, without particular attention to equity issues, the computer revolution has the potential to widen the gap between males and females, whites and minorities, and the rich and the poor (Denbo:1983).

One aspect of computer equity in education concerns access to computers (Winkle and Mathews:1982). The rapid increase in numbers of microcomputers in the schools have raised questions as to which schools and which students will have access to these computers (Becker:April 1983). An additional aspect of computer equity concerns the use of computers once they have been implemented in the schools. Does the child control the computer or does the computer control the child? (Wright and Forcier:1985) Both of these aspects of computer equity are important to the educational achievement of females, minorities, and the poor. The educational advantages and potential economic benefits to be gained from acquiring computer knowledge makes the question of equity a matter of extreme importance for educators (Kulik:1983, Denbo:1983).

Statement of the Problem

Recent reports have revealed that inequities in accessibility and use of computers already exist between males and females, between minorities and Caucasians, and between the rich and the poor (Anderson et al.:1983, Becker:October 1983). It is becoming increasingly clear that women, minorities, and the poor will remain the "have nots" in a new social division based upon those who have computer skills and those who do not. If this is to be prevented, an examination of these inequities must be undertaken by educators and ways must be found to encourage and involve all students in the use of this new technological tool - the computer.

Purpose of the Study

The purpose of this study was to review the research in the field of computer-based education to determine the extent of and reasons for inequities in access to and use of computers by females, minorities, and the poor. It was hoped that a better understanding of these inequities would assist educators in forming strategies for using computers that will increase opportunities for all students.

Organization of the Study

When looking at the body of research which dealt with inequities, certain trends emerged. The annotations were organized to reflect these

trends. The first section consists of surveys and studies dealing with the availability of computers as related to school characteristics. The second section focuses on differences in access to and use of computers as related to user characteristics. The third section focuses on knowledge of computers as related to user characteristics. The fourth section consists of surveys of attitudes toward computers as related to user characteristics. The fifth and final section contains studies of computer use as related to teacher characteristics.

The annotations within each category are arranged chronologically, except in those cases where date of the study was unknown. These annotations are grouped at the end of each category.

Limitations of the Study

The study of inequities in computer access and usage, although quite new, has resulted in an abundance of material. A large percentage of the articles written on this topic were opinion pieces. This study focused on the research that has been done and therefore, these articles were not included. Also, many studies have indicated that inequities exist for other groups - those living in various regions of the United States, private and parochial school students, and the handicapped. This study focused only on inequities as they related to gender, socioeconomic status, and race.

Definitions of Terms

BASIC - "Beginners All-purpose Symbolic Instruction Code. A higher-level computer language introduced in 1965 by Tom Kurtz and John Kemeny of Dartmouth to facilitate students' use of computers for problem solving." (Wright and Forcier:1985)

Chapter 1 - A portion of the Education Consolidation and Improvement Act which repeals and replaces Title I ESEA. Although it contains the same funding formula and the same general purposes of Title I ESEA, it reduces federal supervision, direction, and control over the administration of the program. (McGuire:1982)

computer - "An electronic device that manipulates information . . . according to a list of precise instructions, in order to perform simple operations such as input, manipulate, store, and output information." (Wright and Forcier:1985)

computer assisted instruction (CAI) - "The augmenting of classroom instruction with computer-aided strategies in the areas of drill-and-practice, tutorial, and simulation." (Wright and Forcier:1985)

computer literacy - "Knowledge about the computer and its potential uses and impact on society, as well as a proficiency in applying that knowledge to accomplish a specific task." (Wright and Forcier:1985)

computer programming - "The process of analyzing a problem and then planning and preparing a sequence of instructions for a computer to follow in order to solve that problem." (Wright and Forcier:1985)

computer science - "The study of technical issues related to computers, including the study of internal design and structure as well as various programming languages." (Wright and Forcier:1985)

data processing - "The storage, retrieval, and reporting of information." (Wright and Forcier:1985)

drill-and-practice - "A category of CAI that uses a teaching strategy that consists of presenting questions or problems to students and then providing feedback on the students' responses." (Wright and Forcier:1985)

equity - "Equal access to computers and equality in the ways computers are used. A fundamental issue is whether the child controls the computer or the computer controls the child. Additionally, issues related to sex and socioeconomic status need particular consideration." (Wright and Forcier:1985)

LOGO - "A computer language developed by Seymour Papert and a team of programmers at the Massachusetts Institute of Technology to teach problem solving and programming to children of all ages." (Wright and Forcier:1985)

microcomputer - "A computer at the low end of the price and performance scale, built around a microprocessor chip. At times this term is used interchangably with 'computer' or 'home computer'." (Wright and Forcier:1985)

minority group - "One of the groups classified according to race, religion, or nationality whose membership is less than 50 percent of a given population." (Good:1973)

programming language - "A standard set of words, together with the rules governing their use, for communicating with a computer. Examples are BASIC and LOGO." (Wright and Forcier:1985)

socioeconomic status - "The level indicative of both the social and economic position of an individual or group." (Good:1973)

software - "Computer programs preserved on some type of recording medium." (Wright and Forcier:1985)

Title I - A portion of the Elementary and Secondary Education Act (ESEA) which provides federal funds for compensatory education services for low-achieving children in areas with large numbers of poor children. (McGuire:1982)

word processing - "The use of a device or computer program to edit, format, store, and display text." (Wright and Forcier:1985)

Annotations

Characteristics of Schools Using Computers

Goor, Jeanette and Others. Student Use of Computers in Schools. Fall 1980: A Survey of Public School Districts. Educational Resources Information Center, ED 220 096, National Center for Education Statistics (ED), Washington, D.C., 1981, 35p.

A national survey was conducted in the fall of 1980 through the National Center for Education Statistics' Fast Response Survey System on the availability of computers for instructional purposes in public elementary and secondary schools. The data indicated that larger schools and secondary schools had a greater percentage of microcomputers than small schools and elementary schools. However, student access decreased as district enrollment increased. The survey also revealed that the majority of schools used computers primarily for computer literacy while the least extensive use of computers was for remedial and compensatory education. Usage in all instructional areas increased as the district enrollment increased. Significant increases in the use of microcomputers for remedial and compensatory education were found in the largest school districts.

Hayes, Jeanne. Microcomputer Usage in the Classroom, 1981-1982. Educational Resources Information Center, ED 226 717, Quality Education Data, Inc., Denver, CO, January 1982, 21p.

This document, consisting primarily of detailed data tables, reported on a correlation study of the use of microcomputers for instruction and variables of student enrollement, district wealth, expenditure per pupil, and demographic characteristics. The information was gathered by a telephone survey of United States public school districts. Data indicated that the larger the student enrollment, the more likely the district was to have microcomputers. Urban and suburban schools and schools in wealthier communities were also more likely to have computers. Rural districts and districts with a large percentage of Black or Hispanic minorities were the least likely to have computers.

Update on the School Market for Microcomputers. Educational Resources Information Center, ED 230 192, Market Data Retrieval, Westport, CN, October 1982, 16p.

This document reported on results from Market Data Retrieval's annual telephone survey of all U.S. public school districts. A comparison of the findings in 1981 and 1982 showed the relationship of microcomputer usage and growth trends to enrollment, expenditure, and other characteristics of the schools. Results indicated that the number of schools using microcomputers increased by over 60 percent, with over 24,000 public schools using microcomputers for instruction in 1982. Larger schools and districts and secondary schools were the most likely to have microcomputers. However, smaller schools and districts and elementary schools had much higher growth rates in regard to computer acquisition. Schools with higher proportions of poverty level families were less likely, by more than half, to use microcomputers than were the wealthiest schools.

Ingersoll, Gary M. and Others. "Microcomputers in American Public Schools: A National Survey." Educational Computer, 3: 28-31, October 1983.

This article summarized data gathered during the 1981-82 school year from a survey of over 2,000 teachers and administrators who statistically represented the various regions of the United States. The data showed that microcomputers were located in nearly one-third of the nations public schools. Microcomputers were more likely to be found in secondary schools and larger school districts. The most common location of a school's computer was a media center or specifically designated classroom. At the high school level, the computer was often reported to be in mathematics classrooms.

Wright, Douglas A. and Others. Instructional Use of Computers in Public Schools Spring 1982. FRSS Report No. 14. National Center for Education Statistics, U.S. Department of Education, Washington, D.C., September 1982, 21p.

This publication reported on a national survey conducted in the spring of 1982 through the National Center for Education Statistics' Fast Response Survey System. The survey assessed recent changes in computer availability and obtained data about instructional uses and needs. Thirty-five percent of the nation's public schools used computers for instruction in the 1981-82 school year. Use of computers for instruction and number of computers per school increased as the instructional level increased. Twenty-two percent of the elementary schools used computers for instruction compared to seventy-four percent of the senior high schools. Elementary schools were more likely to use computers for compensatory or remedial instruction and senior high schools were more likely to use computers for computer science courses. Similar percentages of Title I and non-Title I schools used computers for instruction. Non-Title I schools averaged more computers per school but not more time of exposure per student.

Becker, Henry Jay. School Uses of Microcomputers: Reports from a National Survey. Issue No. 1. Educational Resources Information Center, ED 233 111, National Institue of Education (ED), Washington, D.C., April 1983, 10p.

A survey of principals and teachers at 1,600 public, private, and parochial elementary and secondary schools was undertaken by Johns Hopkins University's Center for Social Organization of Schools in 1982 and 1983. This first issue in a series of reports cited data which indicated that the majority of schools in the United States had microcomputers. Secondary schools had more computers and were becoming new users at a faster rate than elementary schools. Small parochial schools and public schools in poorer districts were the least likely owners of microcomputers.

Becker, Henry Jay. School Uses of Microcomputers: Reports from a National Survey, Issue No. 3. Educational Resources Information Center, ED 242 297, National Institute of Education (ED), Washington, D.C., October 1983, 8p.

The third issue in a series of reports based on data from a survey of public and non-public elementary and secondary schools undertaken by Johns Hopkins University in 1982 and 1983 focused on how school ownership and use of microcomputers varied by region, urbanization, type of school, socioeconomic status (SES), and race. The survey data indicated that the majority of secondary schools had at least one microcomputer while elementary schools in the South and parochial schools were the least likely to have one. Elementary schools in the low SES category and schools serving a predominantly minority population were also less likely than others to have a microcomputer. Low SES minority schools used computers for drill and practice actvities and reported intensive use by below average students while low SES white schools used computers to teach programming and reported intensive use by above average students.

Anderson, Cheryl A. and Richard L. Smith. "Instructional Computing Patterns in Texas Schools: Implications for Teacher Training." AEDS Journal, 18: 1-16, Fall 1984.

Anderson and Smith reported on data about instructional computing patterns based on a survey of 200 Texas school districts that were using computers in the spring of 1983. These patterns included student populations, grade levels and curriculum areas that were using computers, instructional applications of computers across grade spans, student computer literacy skills, and teacher training in computer use. The results of the survey indicated that the pattern of use was different for each grade level. Gifted and talented students at the elementary level and regular students at the secondary level had the highest reported usage of computers. Students who spoke English as a second language had the lowest reported usage across all grade spans. In addition, migrant and special education students were reported as having limited access. The authors also found that computer usage increased with grade level and was most often associated with mathematics.

Reisner, Elizabeth R. The Use of Computers in Instruction Supported under Chapter 1 of the Education Consolidation and Improvement Act, Educational Resources Information Center, ED 238 404, Department of Education, Washington, D.C., September 1983, 25p.

This paper examined the accessibility and use of computers by disadvantaged students in Chapter 1 instructional programs. Data from surveys conducted by the four Technical Assistance Centers and results of four additional surveys were analyzed to determine the extent to which computers were used by Chapter 1 students, the kinds of instructional activities for which computers were used under Chapter 1, and the effectiveness of computer-related instruction provided to Chapter 1 students. Discussion of the types of computer-related instruction included differences in computer usage between white and non-white low income schools. The author concluded with suggestions for improving computer-related instruction and an examination of federal responsibilities to Chapter 1.

Watkins, Bruce and David Brimm. "The Adoption and Use of Microcomputers in Homes and Elementary Schools." in Children and Microcomputers: Research on the Newest Medium. Ed. Milton Chen and William Paisley. Beverly Hills, CA: Sage, 1985, 129-150.

The authors reported on two studies designed to assess the current state of microcomputer usage at home, at school, and at work. In the first study, telephone interviews were conducted with a random sample of residents in seven Detroit suburbs. Of the adult respondents, 43 percent indicated that they or their spouses used a computer at work, but only 7 percent indicated that there was a computer in the household. Most households reported at least one member who had never used a computer. Almost half of all children under 12 had access to computers at school and almost 75 percent of children 12 or older had access at school. Better-educated and upper socioeconomic status groups reported greater exposure to computers at work and at home. The second study examined data from a survey of teachers and administrators in a relatively affluent midwestern public elementary school system. Some 84 percent of all teachers reported using computers at some point in their curriculum for an average of five to ten hours per week. Many teachers were unsure of the best way to utilize the classroom computer and were dissatisfied with either the quality or performance of available software. Of those who felt more programs were needed, most cited mathematics as the area most in need.

Sheingold, Karen and Others. Study of Issues Related to Implementation of Computer Technology in Schools. Educational Resources Information Center, ED 210 034, National Institute of Education (DHEW), Washington, D.C., July 1981, 141p.

Case studies of three geographically distinct school districts were conducted to identify ways in which microcomputers were being used and issues which dealt with their implementation. Data from interviews and obsevations revealed six trends important for future research: differential access to microcomputers, the emergence of new roles in response to microcomputers, the lack of integration of microcomputers into elementary classrooms and curriculum, the inadequate quantity and quality of software, the inadequate preparation of teachers for using microcomputers, and lack of knowledge of effects and outcomes. Access to computers was found to be limited for females, average students, and students in schools with inadequate funding.

Characteristics of Computer Users

Anderson, Ronald E. and Others. Computer Inequities in Opportunities for Computer Literacy. Educational Resources Information Center, ED 249 293, National Science Foundation, Washington, D.C., September 1983, 14p.

This document reported on responses to questions regarding computers and computer use included in the 1981-82 National Assessment of Science. The responses revealed information on programming enrollments and the use of computers by students ages 13 and 17 of different race, gender, socioeconomic status, community size, and geographic region. A comparison of these results with results from the 1978 National Assessment showed an increase in programming enrollments by females, minorities, and low socioeconomic status students over the four year span. However, the largest percentage of students in these programs in 1978 and 1982 were white males from wealthy school districts.

West, Jerry and Others. An Analysis of Course-Taking Patterns in Secondary Schools as Related to Student Characteristics. High School and Beyond: A National Longitudinal Study for the 1980's. Educational Resources Information Center, ED 257 633, National Center for Education Statistics (ED), Washington, D.C., March 1985, 135p.

The analysis summarized in this report used 1981-82 High School and Beyond data to identify course-taking patterns relative to mathematics, science, computer science, vocational education, and general education, and to identify the characateristics of students exhibiting these course-taking patterns. Participation in computer science was commonly related to more intense participation in mathematics. High socioeconomic status students and white students were more likely to participate at a more intense level in mathematics, science, and computer science. No major differences were noted with respect to male and female participation in mathematics and computer science.

Hess, Robert D. and Irene T. Miura. "Gender Differences in Enrollment in Computer Camps and Classes." Sex Roles, 13: 193-203, August 1985.

A 1982 survey of twenty-three directors of summer computer camps and classes gathered data on enrollment, type of course sponsorship, level of difficulty of programming classes, and cost. Of the 5,533 students enrolled, the overall ratio of boys to girls in these programs was roughly three to one. The proportion of males enrolled increased with grade, course level, and program cost. The authors concluded with a discussion of possible explanations for the differences in enrollment.

Miura, Irene T. and Robert D. Hess. "Enrollment Differences in Computer Camps and Summer Classes." The Computing Teacher, 11: 22, April 1984.

This article summarized data on 5,533 students obtained from a survey of directors of summer computer camps and classes. The analysis focused on enrollment by grade, sex, socioeconomic status, and ethnic origin, as well as the type of sponsorship and cost. The directors reported that students were predominantly middle and upper income, male, and Caucasian. Sex differences were related to grade level, course level, type of sponsorship, and cost. The disparity between males and females increased with age, was greater in advanced than in beginning classes, and was larger for expensive programs.

Miura, Irene T. and Robert D. Hess. Sex Differences in Computer Access, Interest, and Usage. Educational Resources Information Center, ED 238 400, American Psychological Association, Anaheim, CA, August 1983, 13p.

Miura and Hess reported on three studies which examined sex differences in computer access, interest, and usage in school-aged children. A survey of 87 middle and upper income students in fifth through eighth grade revealed that more boys than girls owned home microcomputers and that use of the home computer differed by gender. A survey of directors of summer computer classes and camps resulted in data on 5,533 students. Enrollment in these programs showed a pattern of three to one in favor of boys for all grade levels. The proportion of girls enrolled decreased as the level of course difficulty and cost increased. Finally, 157 middle school students from three school districts located in lower, middle, and upper income areas were asked to rate a list of 75 software titles for perceived user-interest on a scale of one (male) to five (female). The titles were randomly selected from listings of software developed for three major microcomputer manufacturers. Significantly more of the titles were perceived as being of interest to males than to females.

National Assessment of Educational Progress. The Third National Mathematics Assessment: Results, Trends and Issues. Denver, CO: Education Commission of the States, April 1983.

This publication described and reported results from the Third National Mathematics Assessment conducted during the 1981-82 school year. This report summarized 9, 13, and 17 year old students' attitudes toward mathematics and their abilities in various content areas and cognitive process levels. The chapter on computers and technology revealed data indicating that there had been a significant increase in computer usage in mathematics courses since 1978. A chapter on minorities indicated that Black students, while still performing below the national level, had made greater gains in mathematics performance than White students. Data also showed that in 1982 eleven percent of Black 17 year old students and nine percent of White 17 year old students had taken at least one-half year of computer science. In a chapter on gender differences, it was noted that the average mathematics performance of males and females was not significantly different at ages 9 and 13, but at age 17 the average performance of males exceeded that of females on every level. The percentage of female 17 year old students was less than the percentage of male 17 year old students who had taken at least one-half year of computer science.

Ware, Mary Catherine and Mary Frances Stuck. "Sex Role Messages vis-a-vis Microcomputer Uses: A Look at the Pictures." Sex Roles, 13: 205-214, August 1985.

Three mass market computer magazines were examined for the months of October 1982, January 1983, and April 1983 to determine numbers of males and females depicted in illustrations, roles in which they were portrayed, and their relationship to the computer. Men appeared in illustrations almost twice as often as women. Women were significantly over-represented as clerical workers and sex objects. Men were significantly over-represented as managers, experts, and repair technicians. More than half of the illustrations that contained males and females had males in positions of power. Males were significantly more likely than females to be shown as active users of computers. Only women were shown rejecting the computer or were portrayed as sex objects.

Sanders, Jo Shuchat. "Making the Computer Neuter." The Computing Teacher, 12: 23-27, April 1985.

This article reported on several analyses and studies undertaken in 1984 by the Computer Equity Training Project. First, four issues of large-circulation computer magazines that appeared February through June 1984 were analyzed to identify possible sex stereotyping. Of the 172 photographs of people directly involved with computers, 17 percent showed active computer use by females and 36 percent showed passive computer use by females. Also, 76 percent of the bylined articles were written by men and only 12 percent were written by women. The next study, a survey of home computer ownership and use of 459 seventh and eighth grade students, revealed that 37 percent of the boys had a computer at home as opposed to 20 percent of the girls. Of those who had home computers, patterns emerged of relatively intense use by males and rather diffident use by females. Next, a study of software preferences of 361 seventh and eighth grade boys and girls revealed a clear preference for language arts programs by girls. Finally, an analysis of data gathered through questionnaires distributed to 250 seventh and eighth grade girls revealed two important factors which would encourage girls' computer usage: the presence of their friends in the computer classes and a computer classroom environment that emphasized paired work or discussion among students.

Widmer, Connie C. and Janet Parker. "A Study of Characteristics of Student Programmers." Educational Technology, 25: 47-50, October 1985.

A study of Kentucky's participants in the 1983 and 1984 International Computer Problem Solving Contest collected data on characteristics of student programmers. Participants were fourth through twelfth graders, nine to eighteen years old. Of the 276 participants in 1984, 248 were males and only 28 were females. No significant difference in the contest scores were found with regard to sex. Forty-one percent of the boys had been programming for more than two years, while only seven percent of the girls had been programming for that long. Boys also spent significantly more time per week programming than girls.

Demetrulias, Diana Mayer. "Gender Differences and Computer Use." Educational Horizons, 63: 133-135, Spring 1985.

A survey was conducted in 1984 of 841 computer using students in public and private elementary and secondary schools in Peoria, Illinois. The resulting data indicated that the percentage of students who used microcomputers decreased substantially from the grade schools to the senior high schools. Male users also were found to exceed females at each grade level with the greatest difference found at the senior high school level. No significant differences were found between males and females with regard to frequency of computer usage, average time spent on the computer, and types of software used.

Schubert, Jane G. Females and Microcomputer Use in School: Some Insights into Traditional Patterns. Educational Resources Information Center, ED 244 598, Women's Educational Equity Act Program (ED), Washington, D.C., April 1984, 12p.

This document described a one year American Institutes of Research study of factors that produce inequitable access to computers and computer knowledge for women. Information on 350 "critical incidents" was collected from teachers, students, and parents at 12 elmentary and junior high schools. The findings halfway through the project indicated gender-related differences in computer exposure, interest in software, and out-of-school experience with computers. These differences were illustrated by personal narratives.

Schubert, Jane G. and Others. "IDEAS for Equity in Computer Learning." The Computing Teacher, 12: 40-42, April 1985.

The authors reported on findings of a study conducted by the American Institutes of Research to identify the circumstances and situations that impede computer access and usage. Through observations and interviews, 327 "critical incidents" were collected and analyzed to identify patterns of computer inequities. Females experienced barriers to computers that were not experienced by males. Females experienced difficulty in maintaining interest in the software content. Females also had fewer opportunities to gain out-of-school experiences with computers. A list of twelve barriers to computer access and usage were derived from the data. The article also described a resource titled IDEAS for Equity in Computer Learning which resulted from the study.

Linn, Marcia C. Fostering Equitable Consequences from Computer Learning Environments. Educational Resources Information Center, ED 242 626, National Institute of Education (ED), Washington, D.C., November 1983, 33p.

The Assessing the Cognitive Consequences of Computer Environments for Learning (ACCCEL) project jointly conducted by the Lawrence Hall of Science at the University of California at Berkeley and the Far West Laboratory in San Francisco examined the potential of computer environments for enhancing cognitive skills. This article described the gap between the potential of computers in education and their performance in classrooms, documented differential participation of males and females in computer experiences, and described two studies of how males and females responded to computer learning environments.

Johnson, James E. "Characteristics of Preschoolers Interested in Microcomputers." Journal of Educational Research, 78: 299-305, May/June 1985.

Johnson reported on a study designed to assess the abilities and play preferences of preschool children with various levels of demonstrated interest in and involvement with microcomputers in a nursery school classroom. Data from teachers' ratings of 20 four and five year old children included the kinds of activities preferred and the level of performance. In addition, the children were tested individually on an array of cognitive tasks. Computer users tended to be older, were equally likely to be a boy or a girl, and exhibited significantly higher levels of cognitive maturity.

Hawkins, Jan and Others. "Microcomputers in Classrooms: Impact on the Social Life of Elementary Classrooms." Journal of Applied Developmental Psychology, 3: 361-373, 1982.

The authors reported on two studies which examined some possible social effects of the use of microcomputers in two elementary school classrooms where children were learning to program in Logo. The two classrooms at a private school in Manhattan consisted of 26 eight and nine year old and 27 ten and eleven year old children. The first study examined task-related interactions between children as they worked on both computer and non-computer tasks. The students were significantly more likely to collaborate with each other when they worked with the computers. The second study examined children's perceptions of their peers as resources for help with a variety of classroom tasks. Boys were most frequently nominated as computer experts by their peers. On those occasions when a girl was chosen as a computer expert, she was always selected by another girl.

Knowledge About Computers

Anderson, Ronald E. and Others. Assessing Computer Literacy. Publication # 503. St. Paul, MN: Minnesota Educational Computing Consortium, 1982.

This publication described and reported results of the Minnesota Computer Literacy and Awareness Assessment which was administered to a sample of eleventh and eighth graders throughout Minnesota in 1979. The assessment consisted of three parts: an affective assessment, a cognitive test, and a survey of background variables. Results indicated that while general knowledge and awareness of computers was quite high, specific computer skills and specialized knowledge were lacking. Few students expressed attitudes of fear, anxiety, or intimidation in regard to computers, however, many students reported a lack of confidence in their ability to deal with and use computers. Students that had been exposed to computers demonstrated greater computer awareness and slightly more positive attitudes. No differences in computer literacy were found between urban and rural students. Differences between boys and girls in their awareness and knowledge of computers were quite small.

California Assessment Program. Computer Literacy of California's Sixth and Twelfth Grade Students. Sacramento, CA: California State Department of Education, 1984.

This publication described and reported on a study sponsored by the California Assessment Program of the State Department of Education conducted during the 1982-83 school year. A sample group of sixth and twelfth grade students from throughout the state were tested to determine their knowledge, attitudes, and experiences in regard to computer technology. Boys scored consistently higher than girls did in both grades, and the better performance of boys was associated with greater exposure to computers. Children of more highly educated parents consistently scored higher than children of less well-educated parents. Data also indicated that a majority of students had programming experience by the twelfth grade. However, overall performance by all students on programming objectives was low, and mastery of general knowledge was not much higher.

Fetler, Mark. "Sex Differences on the California Statewide Assessment of Computer Literacy." Sex Roles, 13: 181-191, August 1985.

A statewide survey of the knowledge, attitudes, and experiences in the areas of computer science and computer literacy of California sixth and twelfth grade students was conducted during the 1982-83 school year. Boys' achievement was superior to girls' achievement on nearly all objectives tested and in both grade levels. Performance of girls and boys was most nearly equal on objectives which were the least technical and specialized, that is, on general problem solving skills. Boys had more exposure to computers both at school and at home and tended to have more positive attitudes toward the role of computers in the workplace.

Lockheed, Marlaine E. and Others. "Determinants of Microcomputer Literacy in High School Students." Journal of Educational Computing Research, 1: 81-96, 1985.

A study was undertaken of 413 high school students enrolled in a required introductory computer science course during the 1981-82 school year. The data was analyzed to determine the effects of certain variables on student gains in computer literacy. Gender, grade, mathematics course type, and mathematics section type were all found to be related to gain. Males, younger students, students in sophomore and junior college preparatory mathematics, and students in advanced sections of mathematics courses gained relatively more than did females, older students, and students enrolled in other mathematics courses or section levels. None of the access and experience variables were important determinants of male achievement gain. However, for female students, asking the teacher for help had a positive and significant effect on computer literacy gain.

Attitudes Toward Computers

Wilder, Gita and Others. "Gender and Computers: Two Surveys of Computer Related Attitudes." Sex Roles, 13: 215-228, August 1985.

This article reported on two 1983 surveys designed to provide data about perceptions of and attitudes toward computers. In the first study, a questionnaire was developed and distributed to more than 1,600 students in kindergarten through twelfth grade in Central New Jersey. An analysis of the data indicated that both boys and girls perceived the computer to be more appropriate for boys and that this sex-typing increased slightly with age. Both sexes reported positive attitudes toward the computer, however, boys liked the computer more than girls did at all ages. A steady decline in liking for the computer by both sexes started in the sixth grade. The second study examined the differences between males and females in attitudes toward computers among a highly select and achievement-oriented group of 334 college freshmen. Similar percentages of males and females had home computers and had taken computer courses in high school. More females had taken general introductory computer courses, while more males had taken a programming language course. All students saw the computer as appropriate for both sexes, but agreed that males used it more. Females felt significantly less comfortable and less skilled with computers than did males.

Collis, Betty. "Sex Differences in Secondary School Students' Attitudes Toward Computers." The Computing Teacher, 12: 33-36, April 1985.

Collis summarized results from a 1984 survey of over 1,800 British Columbia eighth and twelfth grade students' attitudes toward computers. Sex differences were found to be more pronounced than age differences with regard to attitudes toward computers. An analysis of the data revealed that males were more interested in computers and less likely to be negative toward the impact of computers on society than were females. Males were also shown to be more self confident than females about their potential with computers. Females in the survey agreed that women in general were as competent as males with computers but that they as an individuals were not competent or likely to be a computer user. The data also indicated that females were less positive after taking a computer literacy course than were their female classmates who had not yet taken the course. Males were significantly more positive after the course experience.

Collis, Betty. "Sex Related Differences in Attitudes Toward Computers: Implications for Counselors." The School Counselor, 33: 120-130, November 1985.

This article reported on results of a survey conducted at two British Columbia school districts in 1984. Data from over 1,800 eighth and twelfth grade students was analyzed to determine sex-related differences in attitudes toward computers which would have implications for counselors. The analysis showed a significant relationship between students' attitudes toward computers and their attitudes toward mathematics, science, and writing. Sex differences were most evident in the mathematics-computer association. Computer users were viewed as bright boys who also liked math and science. When asked who would use a home computer, students in all grades and sex groups nominated men and boys as the most likely users and women, particularly their mothers, as least likely users.

Vermette, Sandra M. and Others. "Attitudes of Elementary School Students and Teachers Toward Computers in Education." Educational Technology, 26: 41-47, January 1986.

The authors reported on a survey of 116 elementary school students' and 50 elementary school teachers' attitudes toward computers. Results indicated that both teachers and students had positive attitudes in regard to computerized education, but expressed negative attitudes in terms of the effects of computer integration on them personally. No significant differences in perceived computer skills, interests, and preferences were found between males and females in the student sample. Some evidence of sex stereotyping was found among teachers. Forty percent of the teachers responded that it was more important for boys to learn about computers than girls, and approximately one-quarter felt that boys like to use computers more than girls.

Moe, Daniel J. The Effects of Sex, Residence Status, Grade Level, and Usage Level on Computer Equity. Educational Resources Information Center, ED 255 182, Master's Thesis, South Dakota State University, 1984, 47p.

A study designed to determine the effects of sex, grade level, residence status, and computer usage on children's attitudes and interests with regard to computers was conducted in the Watertown, South Dakota public schools. An attitude inventory was developed and given to 277 fourth, ninth, and eleventh grade students to measure attitudes toward computer learning related activities, teacher interpersonal relationships and instructional behavior in regard to the computer, the computer from a personal standpoint, and the social structure and climate of one's school in regard to computer utilization. An analysis of the data revealed no significant differences between sexes by any of the grade levels. Attitude scores lowered significantly as grade levels rose. Significant differences were also noted in attitude and interest by usage level.

Loyd, Brenda H. and Clarice Gressard. "The Effects of Sex, Age, and Computer Experience on Computer Attitudes." AEDS Journal, 18: 67-77, Winter 1984.

The effects of age, sex, and computer experience on attitudes toward learning about and using computers as measured by the Computer Attitude Scale were examined in a study of 354 high school and college students. Computer experience was found to be signifcantly related to more positive attitudes on all three of the subscales (computer anxiety, computer confidence, and computer liking). The data did not reveal a clear trend of increase or decrease in computer liking or computer confidence with age. No evidence was found to indicate differences between males and females in computer attitudes.

Enochs, Larry G. "The Effects of Computer Instruction on General Attitudes toward Computers of Fifth Graders." The Journal of Computers in Mathematics and Science Teaching, 3: 24-25, Spring 1984.

This study examined the effects of beginning computer programming instruction on the general attitudes of fifth graders toward computers. Forty-nine predominantly white upper middle class fifth graders from a suburban school were given the General Attitudes Toward Computers survey before and after the programming instruction. The subjects had significantly higher attitudes toward computers following the instruction. No significant difference was found between girls' and boys' attitudes toward computers before instruction. However, an analysis of their attitudes after instruction was not made.

Vrendenburg, Karel and Others. Sex Differences in Attitudes, Feelings, and Behaviors toward Computers. Educational Resources Information Center, ED 255 804, American Psychological Association, Toronto, Ontario, Canada, August 1984, 27p.

A self-report survey was administered to 157 male and 305 female college students enrolled in Introductory Psychology classes at Erindale College, University of Toronto to investigate sex differences in attitudes, feelings, and behaviors toward computers. There was no sex difference in reported access to computers. Males were more likely to have used a computer, to be currently enrolled in a computer course, and to have expressed an intention to purchase a computer. Both sexes perceived computers to be masculine. However, females were more apt to view computers as objects for the exclusive use and enjoyment of males. Females also expressed a greater fear of computers.

Shrock, Sharon A. and Others. Examining the Effects of the Microcomputer on a Real World Class: A Naturalistic Study. Educational Resources Information Center, ED 256 335, Association for Educational Communications and Technology, Anaheim, CA, January 1985, 14p.

A naturalistic study of 12 students, ages seven to nine, in a combined second and third grade classroom in a private rural Southern Illinois elementary school was conducted to determine the impact of the microcomputer on children's behaviorial interactions and responses to available software. Data obtained through observations, questionnaires, and interviews indicated that girls and boys alike had favorable attitudes toward the microcomputer. Boys were more interested in getting the machine to perform different functions and girls were more likely to stay within the dictates of the established program rather than to explore the machine's capabilities.

Jackson, Lorraine M. and Ellen Yamanaka. "Measuring Women's Attitudes, Goals, and Literacy Toward Computers and Advanced Technology." Educational Technology, 25: 12-14, February 1985.

A study of 100 women, 19 to over 49 years of age, from four general community organizations in Canada examined the relationships between women's ages, goals, literacy, and attitudes toward computers and advanced technology. An analysis of the data from several questionnaires revealed that enjoyment of computers was the greatest factor affecting women's goals and technological literacy. Women in the 19-23 year age category had the greatest exposure to computers and the greatest knowledge of computer vocabulary. Women in the 49 years and older category had the least exposure to computers and the least knowledge of computer vocabulary. The majority of women believed that other women would be more knowledgeable about computers than themselves and that men were more knowledgeable about computers than women.

Characteristics of Teachers Using Computers

Becker, Henry Jay. "Men and Women as Computer-Using Teachers." Sex Roles, 13: 137-148, August 1985.

A survey conducted in 1982-83 of principals and teachers at microcomputer owning schools was analyzed in order to determine the characteristics of teachers designated by the principal as the "primary computer-using teacher" (PCUT). In elementary schools, women comprised two-thirds of the PCUTs and in secondary schools, the proportion of women PCUTs was nearly the same as the proportion of women among secondary school teachers as a whole. In elementary schools whose PCUT was a woman, computers were used more for programming instruction and less for drill and practice, and computers were used for more hours and with more positive consequences than where a man was the PCUT. However, in secondary schools, men PCUTs had more involvement with microcomputers, and their schools' use of computers was substantially more intensive than in schools where women were the PCUTs.

Stasz, Cathleen and Others. "Teachers as Role Models: Are There Gender Differences in Microcomputer-Based Mathematics and Science Instruction?" Sex Roles, 13: 149-164, August 1985.

This study of 60 computer using teachers in 25 districts and 49 schools in California examined whether male and female teachers differed in their background or training and their uses of computers to teach mathematics and science. Some differences were noted. Female teachers comprised 65 percent of the elementary teachers and 25 percent of the secondary teachers. On average, male teachers had more coursework in science, math, and computer science than did female teachers. Women took more courses in social science, the humanities, and education. Male teachers had more experiences with different types of computer hardware, and female teachers used more tutorial progarams. However, overwhelming evidence of similarities was found among male and female teachers' subject matter and computer knowledge, patterns of computer-based instruction, and instructional decisions and practices.

Becker, Henry Jay. School Uses of Microcomputers: Reports from a National Survey, Issue No. 6. Educational Resources Information Center, ED 253 219, National Institute of Education (ED), Washington, D.C., November 1984, 13p.

The sixth and final issue in a series of reports based on data from the National Survey of School Uses of Microcomputers in 1982 and 1983 reported on ways in which teachers organized classrooms when they had more students than microcomputers available to them. Results indicated that, in general, students worked at computers individually more often than in pairs or in groups, but that at junior high schools, in particular, students worked more often in pairs. Seatwork was the primary activity of students in a classroom when other students were engaged at the computer. Data also indicated that women teachers had pairs of students work at computers more than did men.

Discussion

The increase in the numbers of microcomputers in the schools has been well documented. A National Center for Education Statistics (NCES) survey in the fall of 1980 found that 26 percent of the nation's public schools had at least one microcomputer (Goor et al.:1981). In the 1981-82 school year, another survey found that 32 percent of schools had a microcomputer (Ingersoll et al.:1983). By the spring of 1982, an additional NCES survey found that 35 percent of the nation's schools had at least one microcomputer (Wright et al.:1982). Finally, a report from a national survey conducted by Johns Hopkins University's Center for Social Organization of Schools revealed that 53 percent of all schools had at least one microcomputer by January of 1983 and that the number of microcomputers in the schools grew at an even faster rate during the latter half of 1982 than expected (Becker:April 1983). The question is no longer <u>if</u> schools will have microcomputers but <u>when</u>.

Several surveys and studies indicated that certain schools were more likely than other schools to have microcomputers. The NCES survey of schools in the fall of 1980 found that larger schools and districts were more likely to have a computer than smaller schools and districts (Goor et al.:1981). Other surveys reported similar findings (Hayes:1982, Ingersoll et al.:1983, Market Data Retrieval:1982). The Quality Education Data (QED) survey found that student enrollment was the strongest predictor of district and school use of microcomputers (Hayes:1982). The annual survey of all U.S. public school districts

conducted by Market Data Retrieval (MDR) in 1982 found that even though larger schools were more likely to have a microcomputer, the rate of growth in smaller schools was 75 percent compared to 8 percent in the larger schools. This would seem to indicate that a relative leveling of distribution was occuring at that time (Market Data Retrieval:1982).

These figures may be misleading with regard to student access to computers. Although larger schools are more likely to have microcomputers, NCES found that, in districts with computers, student access decreased as enrollment increased. In small districts, the estimated ratio of students to computers was 320 to 1, while in larger districts, there were 980 students per computer (Goor et al.:1981). Therefore, while it would seem that students enrolled in larger school districts would be more likely to have access to a computer, the reverse is probably true.

Many of these surveys also found that certain types of schools were more likely than others to have computers. The Johns Hopkins University survey found that senior high schools were more likely to have a microcomputer than elementary schools, with middle and junior high schools falling somewhere in between (Becker:April 1983). Other surveys reported similar findings (Hayes:1982, Market Data Retrieval:1982). The size of the school was also an important factor. The MDR survey and the QED survey found that across all school levels (elementary, junior, and senior high) student enrollment remained an extremely strong predictor of microcomputer use (Hayes:1982, Market Data Retrieval:1982). However, the Johns Hopkins University survey found that even the smallest

secondary schools were more likely to have one microcomputer than were the largest elementary schools (Becker:April 1983).

Socioeconomic status of the community also influenced which schools were more likely to have a microcomputer. The QED survey revealed that the wealthier the community, the more likely the school was to have a microcomputer (Hayes: 1982). The MDR survey found that schools with higher proportions of poverty level families were less likely, by more than half, to use microcomputers than were the wealthiest schools (Market Data Retrieval:1982). These findings were confirmed by other surveys (Becker:October 1983, Wright et al.:1982). As might be expected, home ownership of a computer was also found to be related to socioeconomic status. A survey of Detroit suburban communities found that the higher the household income and level of parental education, the more likely the household was to contain a microcomputer (Watkins and Brimm:1985).

The percentage of minority students enrolled in a district or school was also a factor that influenced school ownership of a computer. The Johns Hopkins University survey found that schools serving a predominantly minority student population were less likely than other schools to have a microcomputer (Becker:October 1983). The QED survey found that school districts with some minority percentage were more likely to have microcomputers if the minority percentage was low (Hayes:1982).

Computers in the schools may be used for remedial and compensatory education, teaching basic academic skills, learning enrichment, computer literacy, teaching computer programming, or computer science. Of those

schools that had microcomputers, the instructional use of computers varies depending upon the schools' characteristics. The 1980 NCES survey found that 85 percent of the nation's schools used computers primarily to teach computer literacy. The least extensive use of computers was for remedial and compensatory education. Larger schools were more likely than smaller schools to use the computer for remedial and compensatory education (Goor et al.:1981). In addition to teaching computer literacy, elementary schools were more likely to use the computer for remedial education, while secondary schools were more likely to use the computer to teach computer science (Goor et al.:1981, Wright et al.:1982). The Johns Hopkins University survey indicated that apart from teaching computer literacy, elementary schools used the computers for drill-and-practice activities, while secondary schools used the computers to teach computer programming (Becker:April 1983). Several surveys indicated that at the secondary level, computer use and computer classes were most often associated with mathematics classes (Anderson and Smith:1984, Ingersoll et al.:1983, Sheingold et al.:1981). This association with mathematics was also found in a study of course-taking patterns of high school students. Participation in computer science was most commonly related to more advanced levels of participation in mathematics (West et al.:1985).

Socioeconomic status (SES) of the community also influenced the instructional use of microcomputers. The 1982 NCES survey found that schools in high SES communities used computers to teach computer literacy and computer science, while schools in low SES communities used computers for remedial and compensatory education (Wright et al.:1982).

This finding was confirmed by West's study of course-taking patterns of high school students. High SES students were twice as likely as low SES students to have earned computer science credit (West et al.:1985).

Several surveys and studies found differences in the instructional use of computers by Title I (now Chapter 1) schools and non-Title I schools. The 1982 NCES survey found that Title I schools used computers for remedial and compensatory education more than did non-Title I schools. Non-Title I schools emphasized teaching computer literacy and computer science more than did Title I schools (Wright et al.:1982). These findings were confirmed by the 1981-82 National Assessment of Science which found that only 7 percent of students in Title I schools had taken computer programming, while 14 percent of students in other schools had taken such courses. Another study indicated that computers at the elementary and middle school level were used by Title I students for remedial work (Sheingold et al.:1981). Surveys conducted by four Technical Assistance Centers found that Chapter 1 students were more likely to use the computer if it was primarily intended to provide remedial instruction and less likely to use the computer if it was intended for enrichment purposes. Chapter 1 schools tended to use the computer for drill-and-practice activities to a greater extent than non-Chapter 1 schools (Reisner:1983). These differences may be related to Title I requirements which prohibit the use of Title I funds for general aid. Title I purchased equipment (computers) must be used in Title I schools to benefit Title I students only. Since Title I students tend to be below-average in achievement, it was not surprising

that these schools used computers for remedial and compensatory education (Reisner:1983, Sheingold et al.:1981).

Very few surveys and studies found differences in the instructional use of computers between predominantly minority schools and predominantly white schools. The Johns Hopkins University survey found that differences in instructional usage between predominantly minority schools and predominantly white schools was related to socioeconomic status of the surrounding community. Low SES predominantly minority schools used the computer for drill-and-practice activities much more than for programming activities. Low SES predominantly white schools used the computer for programming activities more than for drill-and-practice activities. Low SES predominantly minority schools also reported intensive use by below-average students, while low SES predominantly white schools reported intensive use by above-average students (Becker:October 1983). These differences seem to indicate that in poor minority communities, those schools that had microcomputers were trying to use them to bring up the achievement level of their lower-performing students. In poor white communities, those schools that had microcomputers were trying to use them to further the educational advantages of their better-performing students.

Although there were few differences found in instructional usage between predominantly minority schools and predominantly white schools, there was evidence to suggest that minority students in all schools used computers less and in a different manner than white students. A survey of Texas schools found that students who spoke English as a second language and migrant students had the lowest reported usage of computers

(Anderson and Smith:1984). In another study, non-English speaking immigrants used the computers for math drill-and-practice activities since these programs were not as language-dependent as traditional school work (Sheingold et al.:1981). A survey of directors of summer computer camps and classes revealed that 98 percent of the students enrolled were Caucasians, 5 percent were Asians, 2.5 percent were Blacks, and 1 percent were Hispanics (Miura and Hess:1984). In a study of course-taking patterns of high school students, white students were more likely to have earned computer science credit than either black or Hispanic students (West et al.:1985). Finally, two National Assessments indicated that these differences in computer usage may be diminishing for black students. The 1982 National Assessment of Mathematics found that similar percentages of black and white 17 year old students had taken at least one-half year of computer science (National Assessment of Educational Progress:1983). The 1982 National Assessment of Science found no significant differences between black and white students' exposure to computers and enrollment in computer programming courses (Anderson et al.:1983).

Females form an additional group of students who have experienced limited access to and use of computers. The Lawrence Hall of Science reported that only 27 percent of the high school students enrolling in computer courses were female (Linn:1983). A study of California sixth and twelfth grade students during the 1982-83 school year found differences in reported access to computers between males and females. A significantly greater proportion of females than males reported no school access to computers, no microcomputer learning experiences, and

limited knowledge about computers (California Assessment Program:1984, Fetler:1985). In a study of the implementation of computers in three school districts, more males than females were observed using microcomputers. At the elementary level, the male/female ratio was 1.6 to 1, and at the high school level the ratio was 3.5 to 1 (Sheingold et al.:1981). Even when the computer learning situation was not school related, females were less likely to participate. In a study of enrollment in summer computer camps and classes, 74 percent of the students enrolled were males, while only 26 percent were females (Miura and Hess:1984).

Other studies found that females had limited access to and use of computers in the home. A survey of middle and upper income fifth through eighth grade students revealed that, of those students who reported owning a home computer, the majority were males (Miura and Hess:1983). Another survey of seventh and eighth grade students found that 37 percent of the males had a computer at home, while only 28 percent of the females had one. When asked who used the home computer most, males were three times as likely as females to say they used the computer most at home (Sanders:1985). In a study of computer use by home computer owners (which included adults as well as children), there was a general absence of gender differences. However, seven percent of the females in the study reported that they watched others use the computer, while none of the males reported doing so (Watkins and Brimm:1985).

Females' use of computers was found to be related to age and grade level. A study of characteristics of preschool children found that

males and females were equally likely to use the microcomputer (Johnson:1985). In a study of enrollment in summer computer camps and classes it was found that gender differences were significantly related to the age of the student. More females were enrolled at the early grade levels. The proportion of females was 30 percent in the primary grades, 26 percent in the middle school grades, and 24 percent in the high school grades (Hess and Miura:1985). A survey of elementary and secondary students found that the percentage of students who used computers decreased substantially from the grade schools to the senior high schools. Male users were found to exceed female users at each grade level, with the greatest difference found at the senior high school level (Demetrulias:1985). In another study, microcomputers appeared to be used equally by males and females in the elementary grades. However, starting in the seventh grade, there was much greater use by males (Sheingold et al.:1981). In a study of undergraduate students, a greater number of males reported having used a computer and males were six times more likely to be currently enrolled in a computer course (Vrendenberg et al.:1984).

Additional studies found that female computer usage differed qualitatively from that of males, especially with regard to programming. Two studies of elementary students found that females preferred drill-and-practice software and language arts programs. Males preferred software which allowed for creative control of the computer (Shrock et al.:1985, Sanders:1985). In California, a study found that females constituted 42 percent of the students in high school instruction which involved computers. The data also indicated that they were

over-represented in some courses and under-represented in others. Females represented 86 percent of the students in word processing courses and 56 percent of the students in data processing courses, but only 37 percent of the students in programming courses (Linn:1983). Another study revealed that at the high school level, a majority of the students in programming classes in the mathematics department and in data processing classes in the business department were males (Sheingold et al.:1981). In a survey of college freshmen, of those students who had taken computer courses in high school, females were more likely to have taken a general introductory course, while males were more likely to have taken a programming language course (Wilder et al.:1985).

The 1981-82 National Assessment of Science found that while there were no significant differences in the number of males and females reporting any use of computers, females were less likely to have taken computer programming classes. Only 8 percent of the females, compared to 14 percent of the males, reported enrollment in a programming course for at least one semester (Anderson et al.:September 1983). Similar percentages were cited by the 1981-82 National Assessment of Mathematics (National Assessment of Educational Progress:1983). The California Assessment Program found that, of the learning done at school, males were more likely than females to have been involved in programming. Twelfth grade students were asked to indicate the programming languages they had used. The percentage of males was greater for each option execpt for the option "None", and for this option the percentage of females was greater (California Assessment Program:1984). A study of enrollment in summer computer camps and classes found that differences

in enrollment by males and females was related to the course level. The proportion of females enrolled in beginning and intermediate programming classes was 28 percent, the proportion enrolled in advanced programming was 14 percent, and the proportion enrolled in assembly language classes was only 5 percent (Hess and Miura:1985). Finally, a survey of the Kentucky student participants in the 1984 University of Wisconsin-Parkside International Computer Problem Solving Contest revealed that, of the 276 participants, 248 were males and only 28 were females. Almost half of the males had been programming for more than two years, while only 7 percent of the females had been programming for that long. Ninety-three percent of the females had begun programming only the year before the contest (Widmer and Parker:1985).

Several studies indicated that these inequities in access to and use of computers resulted in lower achievement in computer literacy for females. In an assessment of computer literacy of California sixth and twelfth grade students, males in both grades had generally higher scores than females did. Relative strengths of sixth grade males were on questions about vocabulary, system components, and simple programming. Relative strengths of twelfth grade males were in the areas of computer functions and uses, hardware, and computer science problem solving. In both grades, performance of males and females was most nearly equal on objectives that were the least technical and specialized, that is, on general problem solving skills (California Assessment Program:1984, Fetler:1985). In a study of determinants of computer literacy in high school students, gender was significantly related to achievement gain in computer literacy. Females gained less than expected and males gained

more than expected. Access to and experience with computers were generally unrelated to gain with two exceptions: 1) asking the teacher for help was a determinant of gain for female students and 2) access to computers outside of school was a determinant of gain for ninth and tenth grade female students. The grade level and type of mathematics class were also significant predictors of achievement gain for female students (Lockheed et al.:1985). In only one study did females perform as well as males in computer literacy. A study of Minnesota eighth and eleventh grade students found that females scored as highly as males on a test of programming skills, and for some questions, especially where the problem was expressed in words, the females did better than the males. These findings may be due to a statewide policy, begun in 1971, designed to produce equal distribution of computing opportunities throughout Minnesota (Anderson et al.:1982).

Gender differences in attitudes toward computers were examined in several studies. In a study of New Jersey kindergarten through twelfth grade students, both males and females expressed positive attitudes toward computers. However, males liked the computer more than females at all ages (Wilder et al.:1985). A naturalistic study of elementary school students found that, while both males and females expressed positive attitudes toward the microcomputer, observations of behavior indicated that males felt more competent than females with computers (Shrock et al.:1985) Two studies found that positive attitudes of both males and females toward computers declined as grade level increased (Moe:1984, Wilder et al.:1985).

One study of secondary school students' attitudes found that males were more interested in computers than females and more self-confident than females about their potential with computers. The typical female felt that males and other females were better able than herself to learn to use computers (Collis:April 1985). A study of first year college students' attitudes found that females felt less comfortable than males in dealing with computers. Females also felt less well-equipped than males to deal with computers (Wilder et al.:1985). Another study of college students' attitudes found that males liked computers more than did females. Females expressed a greater fear of computers and felt that this fear of computers was typical of most women (Vrendenberg et al.:1984). However, one study found that computer anxiety, computer confidence, and computer liking were all quite similar for males and females in both high school and college (Loyd and Gressard:1984). Finally, a study of women ages 19 to over 49 found that women who indicated a higher interest and enjoyment level in computers also had higher technical goals and better understanding of technical terms. The majority of these women believed that other women would be more knowledgeable than themselves about computers (Jackson and Yamanaka:1985).

Female attitudes toward computers and its association with mathematics were also examined. A study of high school students' attitudes toward all subjects found significant relationships between students' attitudes toward computers and their attitudes toward mathematics, science, and writing, but gender differences were most evident in the mathematics-computer association. Females were more

likely than males to associate negative feelings about mathematics with negative assumptions about computer use and users (Collis:November 1985). In another study, sixth grade students tended to believe that "computers can help make mathematics more interesting." However, of those students who strongly agreed with this statement, 61 percent were males and only 39 percent were females. Twelfth grade males and females responded in a similar way. A somewhat different attitude was expressed by responses to the statement that "to work with a computer, a person must be a mathematician." Similar percentages of males and females agreed or strongly agreed with this statement. However, males were more likely than females to disagree or strongly disagree (California Assessment Program:1984). Perhaps males tended to disagree with this statement more than females because their greater exposure to and experience with computers has shown this assumption to be false.

Several studies examined differences in attitudes before and after exposure to computer learning experiences. One study found that computer experience was significantly related to more computer confidence, greater computer liking, and less computer anxiety (Loyd and Gressard:1984). Another study indicated that attitude was related to usage level. Students who reported high computer usage levels also had more positive attitudes toward computers (Moe:1984). A study of fifth grade students found that both males and females had significantly more positive attitudes toward computers after computer programming instruction (Enochs:1984). In a study of college freshmen, data indicated that any previous experience with the computer made both males and females feel more comfortable in dealing with the computer.

However, only learning a programming language increased females' sense of computer competence. For males, any previous experience increased their sense of computer competence (Wilder et al.:1985). A study of secondary school students indicated that mandatory computer courses resulted in more confident and enthusiastic attitudes among male students. However, females who had taken the course were less self-confident and more negative about computers than were the females who had not yet taken the course (Collis:April 1985). In another study, earlier exposure to computers seemed to make a difference in females' willingness to continue their computer learning. The male coordinator of a seventh grade computer class remarked that an increasing number of females began to sign up for computer classes during the second year these classes were offered. It was learned that many of these females had come from the sixth grade feeder school with a mandatory computer literacy class (Schubert:1984).

Data from several studies revealed that computers were male sex-typed. In one study, when college students were asked "If a computer were a person, would it be male or female?", three-fourths of both males and females responded that it would be male. Females were more likely than males to view the computer as an object for the exclusive use and enjoyment of males (Vrendenberg et al.:1984). In a study of kindergarten through twelfth grade students, both male and female students perceived the computer to be more appropriate for males than for females. This perception of computers as more male-appropriate increased with age (Wilder et al.:1985). Computer software was also found to be sex-typed. In a study of computer software titles, more

titles were perceived by adults and students as being of interest to males than females. Approximately one-third of the titles were rated as being of primary interest to males, compared to five percent that were rated as being of primary interest to females (Miura and Hess:1983). Evidence of sex stereotyping was also found among teachers' attitudes. A large percentage of teachers strongly agreed that it was more important for males to learn about computers than females (Vermette et al.:1986). There were also indications in several studies that parents tended to encourage their sons rather than their daughters to take computer courses and use the home computer (Fetler:1985, Hess and Miura:1985, Schubert:1984).

Perceptions of computer users as males were also found. In a study of childrens' perceptions of their classroom peers as resources for help with computer tasks, males were most frequently nominated as experts. On those occassions when a female was chosen as a helper, she was always selected by another female (Hawkins et al.:1982). A study of eighth and twelfth grade students found that females tended to have a stereotyped, somewhat negative view of computer users. Females were more likely than males to view computer users as bright males who also liked math and science, but who were not perceived as being socially attractive (Collis:November 1985).

It has been suggested that this sex stereotyping of computers and computer users is a result of exposure to similar views expressed in the media. Two studies analyzed computer magazines to determine if this was true. In a survey of four issues of large-circulation computer magazines from February through June of 1984, a total of 172 photographs

were analyzed according to sex and passive versus active use. Of the 28 photographs showing passive computer use, 36 percent were pictures of females. Of the 144 photographs showing active computer use, only 17 percent were pictures of females. Of the 91 bylined articles in these magazines, 76 percent were written by men and only 12 percent by women (Sanders:1985). Another study examined three mass market computer magazines for the months of October 1982, January 1983, and April 1983. Of the individuals pictured with computers, 30 percent were females and 70 percent were males. The magazines' portrayal and the actual distribution of males and females in the population of the United States at that time were significantly different. Males were far more likely than females to be shown as active users of the computer. Only females were shown rejecting the computer. Females were significantly under-represented as managers, experts, and repair technicians. Females were significantly over-represented as sellers, clerical workers and sex objects. Males were never shown as sex objects. Of the 76 photographs containing both males and females, 43 showed males in positions of power, 22 showed equal distribution of power, and only 11 showed females in positions of power (Ware and Stuck:1985).

Finally, since teachers influence their students directly and indirectly, several studies were included that examined computer using teachers. A study of California computer using mathematics and science teachers, found some gender differences in subject-matter and computer knowledge. Male teachers had more coursework in science, mathematics and computer science than did female teachers. Female teachers took more courses in social science, the humanities, and education. Gender

was generally unrelated to teachers' knowledge of computers. Both male and female teachers had used a number of different courseware packages during the school year, had applied computers outside their work in a number of different ways, had used several different types of hardware, and had written programs in one or more computer languages. The instructional uses of computers were unrelated to gender, but depended more upon the teachers' interests and instructional inclinations. Four clusters of instructional usage were identified, and equal numbers of male and female teachers were found in each cluster. Only one difference was noted which related to male and female teachers' instructional use of computers. Female teachers used more tutorial programs than did male teachers (Stasz et al.:1985). The Johns Hopkins University survey found that male and female teachers used similar methods of organizing classrooms when they had more students than microcomputers. However, female teachers frequently had pairs of students work at computers, while male teachers had students work individually at computers more often (Becker:November 1984).

A study of teachers identified as the "primary computer using teacher" (PCUT) by their principals found that, in elementary schools the PCUT was most likely to be a female. However, at the secondary level, men PCUTs were more numerous at schools in high SES neighborhoods and in schools with male principals, while women PCUTs were more numerous at schools in poor areas, in predominantly minority schools, and in schools with female principals. In elementary schools, both male and female PCUTs used microcmputers mainly as part of mathematics instruction. In secondary schools, both male and female PCUTs used

computers as an object of instruction. In elementary schools, female PCUTs were more positive about computers, more flexible, and more innovative than were male PCUTs. Female PCUTs were also more likely to use the computer for programming instruction and less for drill-and-practice activities than were male PCUTs. In secondary schools, male PCUTs had more personal involvement with computers than did female PCUTs, and their students used the computers for more time during each week than students of female PCUTs. Finally, secondary schools with a female PCUT were just as likely to have a computer club as those schools with a male PCUT. However, membership in these clubs was more likely to include a balanced proportion of male and female students when the PCUT was female (Becker:1985).

Conclusions

School microcomputer use is increasing and will continue to increase at a fast pace. In the near future it appears that nearly every school in the United States will have at least one microcomputer for instructional usage. However, until the time comes when there is a computer for every student, inequities in access to and use of computers will exist. Educators must be aware of these inequities if they are to provide equal opportunities for learning about computers to all students, especially females, minorities, and the poor.

Computer equity concerns two aspects, access to computers and use of computers. Students in lower-income communities have limited access to computers in school as well as at home. As expected, this is due to the cost of microcomputers. Perhaps as cost decreases their access to computers will increase. At the present time, they are far behind the students in wealthier communities and they may never catch up.

Federal funds have been targeted for schools in these low-income communities through Title I ESEA and Chapter 1 ECIA. However, even when these funds are used to purchase computers and increase access, students in these schools use computers in different ways than students in wealthy schools. Their use of computers for remedial and compensatory education contrasts qualitatively with affluent students' use of computers for computer programming and computer science. Daniel Watt, former research associate for the MIT Logo Group and current editor with Byte Books, suggests that, "Affluent students are thus learning to tell

the computer what to do, while less affluent students are learning to do what the computer tells them." (Watt:1982)

Minority students also experience these inequities in computer education. Predominantly minority communities are often low-income communities. These minority students experience limited access to computers for the same reasons as low-income students. However, even when minorities have access to computers in schools, they are still less likely to use them. This seems to be partly due to the strong association between mathematics and computers. The 1982 National Assessment of Mathematics indicated that minorities were performing below the national average in mathematics achievement (National Assessment of Educational Progress:1983). If computer courses are offered as elective or advanced mathematics classes, some minority students may have limited access to computers because of their lower achievement levels in mathematics.

This association with mathematics may also be related to their use of computers. In the past, minority students have not participated in computer programming courses which are usually offered as mathematics electives. Minority students who use computers tend to use them for drill-and-practice activities or remedial education. Perhaps this use is related to their socioeconomic status. As was found with low-income students, minorities are learning to do what the computer tells them to do rather than telling the computer what to do.

Females also experience limited access to and use of computers. However, the reasons for this are different than for low-income or minority students. Computers, computer users, and computer software are

viewed as male sex-typed by both males and females, children and adults. Females appear to avoid computers and computer programming courses because of this sex-typing. However, females are more willing to use computers for language arts, word processing, and data processing because these uses are strongly female sex-typed. Teachers and parents also hold these stereotyped views and are less likely to encourage females' use of computers. Females' knowledge in computer literacy is lower than males, but this is expected given their stereotyped view of and limited access to computers.

Females' attitudes toward computers influence their use of computers, and their use of computers influence their attitudes. Females associated negative feelings about mathematics with negative assumptions about computer use and users. Perhaps, greater experience with computers outside of mathematics classes would dispel this association. Their attitudes toward computers are generally positive. However, females feel less confident than males in their abilities to use computers and are more likely than males to fear computers. Previous positive experience with computers changed these attitudes and made females more willing to continue learning about computers.

Teachers must be aware of these differences in computer access and use for the poor, minorities, and females. As role models and guides, their use of computers in classrooms can reinforce these inequities or destroy them.

Recommendations

It is recommended that:

1. States continue to develop equitable finance measures to insure that education resources are distributed evenly (Hunt:1983).
2. Low-income students, minority students, and female students be encouraged to use computers for computer programming and computer science.
3. Research be conducted on low-income and minority students' knowledge of and attitudes toward computers.
4. Computers be used in other subject areas in addition to mathematics.
5. Variations of the traditional computer programming and computer science courses be offered as non-mathematics electives.
6. Counselors, teachers, and parents encourage groups of female friends to take computer courses (Sanders:1985).
7. Computer environments emphasize cooperative work at computers for females (Sanders:1985).

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